Five-year follow-up of oral functioning and quality of life in patients with oral cancer with implant-retained mandibular overdentures

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FIVE-YEAR FOLLOW-UP OF ORAL FUNCTIONING AND QUALITY OF LIFE IN PATIENTS WITH ORAL CANCER WITH IMPLANT-RETAINED MANDIBULAR OVERDENTURES

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Abstract: *Background.* The purpose of this prospective study was to assess the quality of life (QOL) and oral functioning of patients with oral cancer up to 5 years after prosthodontic rehabilitation with mandibular implant-retained overdentures.

Methods. Fifty patients who had received implants during ablative surgery were evaluated by standardized questionnaires before and after oncological and prosthetic treatment.

Results. In 20 of 24 surviving patients, the dentures were functional after 5 years. In these survivors, oral function remained unchanged during this period. In the 6 patients with concurrent comorbidity, global health and QOL had deteriorated, while in the patients without comorbidity, global health and QOL were very high. Five-year survivors had a higher global health and better oral functioning at the 1-year evaluation than nonsurvivors.

Conclusion. Oral function and denture satisfaction were high and did not change over time for survivors. Deterioration in overall global health and QOL was associated with concurrent comorbidity. © 2010 Wiley Periodicals, Inc. *Head Neck* **33:** 831–839, 2011

Keywords: head and neck cancer; edentulous; dental implants; dental prosthesis; quality of life

Prosthodontic rehabilitation in patients with oral cancer is challenging as oral functioning is hampered due to the surgical treatment and the subsequent radiotherapy. As a consequence of this combined treatment, wearing a mandibular prosthesis is severely impeded due to the changed anatomic conditions and the intolerance of the denture-bearing mucosa to mechanical loading.[1–4] A solution for this problem might be to provide the patients with an implant-retained mandibular overdenture. Implant survival in irradiated mandibles, although generally lower than in healthy patients, has still been shown to be relatively high in most articles shown in the literature, and patients have reported an improved level of oral functioning when provided with such a denture.[5–13] Also, assessment of the effect of such a treatment on the patients' functioning and overall quality of life (QOL) is of the utmost importance.[14–20]

In healthy subjects, no clinically relevant changes in oral functioning and patient satisfaction are to be expected after the first year of prosthodontic rehabilitation with an implant-retained overdenture.[21,22] In patients with oral cancer, it is questionable whether this is also applicable, or whether the remaining side effects of the oncological treatment and the impact of having had cancer are more prominent and veil the beneficial effect of an adequate prosthodontic rehabilitation on oral function and QOL. Thus, the purpose of this prospective study was to assess oral functioning and QOL in patients with oral cancer in whom implants had been installed during ablative tumor surgery, up to 5 years after prosthodontic rehabilitation with implant-retained mandibular overdentures.

MATERIALS AND METHODS

Patients and Treatment. All consecutive edentulous patients with oral cancer referred to the Head and Neck Oncology group of the University Medical Center Groningen between May 1998 and April 2002 were screened to be included in this study. Inclusion criteria were edentulous upper and lower jaw, history of prosthetic problems related to the lack of stability, and retention of the lower denture or expected denture-related problems after oncology treatment, first

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malignancy in head and neck region (squamous cell carcinoma of the tongue, floor of mouth, mandibular gingiva, buccal mucosa, or oropharynx), and the need for primary ablative surgery. The patients were screened by an experienced maxillofacial surgeon (G.M.R.) and prosthodontist (H.R.). It was required that little or no improvement was to be expected from making new dentures after oncological treatment. Patients were offered conventional or implant-based treatment. Fifty-three patients fulfilled the inclusion criteria and 50 patients accepted the option of implant installation during ablative surgery. Two patients refused to have implants installed and 1 patient had never worn a prosthesis. Informed consent was provided from all patients before treatment.

Tumor surgery and implant insertion were performed at the University Medical Center Groningen. All implants (3.75 mm Brånemark screw implants with a machined surface, Nobelbiocare, Gothenburg, Sweden) were inserted during the ablative tumor surgery procedure. All implants were placed in the interforaminal region of the native bone of the mandible in a 2-stage surgical procedure. A 3-month osseointegration period before abutment connection was considered in patients not having radiotherapy after tumor surgery (18 patients). If postoperative radiotherapy was scheduled (32 patients), in general, starting within 6 weeks after surgery, the osseointegration time before abutment connection was increased to 9 months after surgery. All patients were treated by 1 maxillofacial surgeon (G.R.) and 1 prosthodontist (H.R.). Details are described in the article by Schoen et al.[10]

Functional Assessments and Quality of Life. Preoperatively, on the day of hospital admission (T_0), patients were asked to complete questionnaires regarding oral functioning and QOL. The questionnaires were administered by an investigator not involved in treatment of the patients (P.S.). Similar questionnaires and questionnaires regarding denture satisfaction and the impact of denture-related problems on social activities had to be completed 6 weeks (T_1), 1 year (T_2), and 5 years (T_3) after placing the new dentures.

QOL was assessed using the core questionnaire (Quality of Life Questionnaire-Core 30-questions [QLQ-C30]) and head and neck module (Quality of Life Questionnaire-Core 30 Head and Neck 35-questions [QLQ-H&N35]) of the European Organization for Research and Treatment of Cancer (EORTC).[23] Psychological, physical, and social impact of oral disorders was assessed using the Oral Health Impact Profile (OHIP).[24] General QOL was assessed with the Linear Analogue Self Assessment method (LASA; 1-item version).[25] Denture satisfaction was assessed using a validated questionnaire consisting of 8 separate items focusing on the function of upper and lower dentures, and on specific features such as aesthetics, retention, and functional comfort.[26] Overall denture satisfaction was expressed on a 10-point rating scale (0–10); 0 being completely dissatisfied, to 10 being completely satisfied. Subjective chewing ability was assessed using a 9-item questionnaire on which the patient could rate on a 3-point scale their ability to chew different kinds of food.[27] Impact of denture problems on social activities, such as going out, and contacting and visiting people, was assessed with the Groningen Activity Restriction Scale Dentistry.[28]

Data Analysis. The obtained data were evaluated using SPSS (version 16.0 for Windows, SPSS, Chicago, IL). Data are shown as means ± SD. Changes were stated as significant if $p < .05$. When comparing different groups of patients at the same time, the Mann–Whitney test was used. When comparing results within groups at different times, the Wilcoxon signed-rank test was applied.

RESULTS

Patients and Implants. Patient characteristics are presented in Table 1. In total, 50 patients, 35 men and 15 women (mean age, 61.5 ± 11.2 years; range, 41–81 years) were included at T_0.

In total, 195 implants were placed in the initial group of 50 patients; of them, 18 patients were treated with surgery only (72 implants) and 32 patients were treated with radiotherapy in addition (123 implants). During the 5-year follow-up, a total of 14 implants were lost; 13 implants in 6 patients who received radiotherapy (implant survival rate 89.4%) and 1 implant in a non-irradiated patient (implant survival rate 98.6%).

At T_2, 1 year after denture placement, 35 overdentures were in function. Twelve patients had died (48 implants), 7 before abutment connection. Two patients had refused abutment connection (6 implants), because they did not want any additional, nontumor-related, surgery; and 1 patient had already lost 3 implants before abutment connection. The results of T_2 have been published previously.[10] At T_3, 5 years after denture placement, 26 patients were deceased. Another 4 patients who survived T_3 had to be excluded from follow-up due to removal of the superstructures related to local irritation ($n = 2$), loss of 3 implants ($n = 1$), and the impossibility of making a denture after ablation because of derived anatomic limitations ($n = 1$). Of the remaining 20 patients with functional dentures at T_3, 9 patients were irradiated (45%).

Quality of Life and Functional Assessments

European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30-Questions and Quality of Life Questionnaire-Core 30 Head and Neck 35-Questions. The results of the EORTC QLQ-C30 and QLQ-H&N35 questionnaires are presented in Table 2. The results of the evaluations after 1 and 5 years are presented for patients who survived T_3 ($n = 20$), divided into irradiated (RTX; $n = 9$) and non-irradiated patients (non-RTX; $n = 11$). Hardly any differences between and within the groups were found. In the total group, the

Table 1. Patient characteristics.

Age at diagnosis, y	Sex	Primary tumor	Stage	Total intraforaminal dose, Gy	Status
57	F	Mandibular gingiva	T4N1	–	1 (NTR)
59	M	Floor of mouth	T4N2b	–	1 (NTR)
77	F	Tongue	T3N2b	64	1 (TR)
79	M	Floor of mouth	T4N0	60	1 (TR)
52	F	Tongue/floor of mouth	T2N1	64	1 (TR)
53	M	Floor of mouth	T4N0	65	1 (TR)
69	M	Oropharynx	T2N2b	64	1 (TR)
81	M	Oropharynx	T3N1	30	2 (NTR)
52	F	Tongue	T2N1	58	2 (NTR)
61	M	Mandibular gingiva	T2N0	64	2 (TR)
81	F	Tongue/floor of mouth	T2N0	–	2 (TR)
50	M	Mandibular gingiva	T4N2b	61	2 (TR)
75	M	Tonsil	T2N0	–	3 (NTR)
64	M	Floor of mouth	T2N2c	59	3 (NTR)
59	M	Tonsil	T3N0	60	3 (NTR)
68	F	Floor of mouth	T2N0	–	3 (NTR)
65	M	Mandibular gingiva	T2N0	–	3 (NTR)
49	F	Base of tongue	T3N1	58	3 (NTR)
66	M	Mandibular gingiva	T4N2b	67	3 (NTR)
48	M	Floor of mouth	T4N1	55	3 (NTR)
78	F	Mandibular gingiva	T1N0	–	3 (NTR)
54	M	Mandibular gingiva	T4N1	62	3 (NTR)
70	M	Mandibular gingiva	T4N2b	50	3, 4 (NTR)
50	M	Floor of mouth	T2N1	65	3 (TR)
66	M	Mandibular gingiva	T4N2b	64	3 (TR)
59	M	Oropharynx	T4N2b	61	3 (TR)
49	F	Floor of mouth	T2N0	57	4
76	F	Mandibular gingiva	T4N0	64	4
49	M	Floor of mouth	T2N0	50	4 (after 1 y)
71	M	Tonsil	T3N1	67	4 (after 1 y)
43	M	Tongue/floor of mouth	T2N0	–	5
65	M	Floor of mouth	T2N1	70	5
43	F	Tongue	T1N0	–	5
55	F	Tongue	T2N0	–	5
77	M	Tongue	T1N0	–	5
56	F	Floor of mouth	T1N0	–	5
41	M	Base of tongue	T3N0	63	–
54	M	Tongue	T2N1	46	–
51	F	Floor of mouth	T1N0	61	–
64	M	Mandibular gingiva	T4N0	62	–
52	M	Oropharynx	T3N0	12	–
65	M	Floor of mouth	T2N0	–	–
63	F	Tongue	T3N2c	62	–
46	M	Tongue	T3N0	64	–
54	M	Mandibular gingiva	T1N0	–	–
69	M	Tongue	T2N0	–	–
71	M	Tongue	T2N0	–	–
72	M	Tongue	T2N0	–	–
66	M	Tongue	T3N2b	66	–
80	M	Tongue	T2N0	–	–

Abbreviations: F, female; M, male; NTR, not tumor-related; TR, tumor-related.
Notes: Patient characteristics regarding age, sex, primary tumor, staging, total interforaminal dose of radiotherapy, and status: 1: died in first year, before prosthesis could be made; 2: died in the first year after delivery of prosthesis; 3: died after first year, but before 5-year evaluation; 4: wears no prosthesis; 5: comorbidity notified at T3.

reported global health and general health after 5 years was lower than after 1 year ($p < .05$) and general QOL tended to decrease ($p = .070$). Weight loss had increased in 4 years. In irradiated patients, the mouth opening was reported more restricted and dry mouth was more severe (only significant after 1 year; $p < .05$).

Comorbidity. Based on the data in the patients' medical histories, patients were subdivided into 2 groups based on the comorbidity noticed at T_3 (Table 3). Six patients were identified with comorbidity, including secondary radiotherapy (after T_2) in the head and neck region ($n = 2$), an established stroke, lung metastases, severe lung emphysema, and a transient ischemic attack (Table 1). When looking into detail in these patients, global health, physical function, fatigue, and dyspnea were significantly worse in these patients with comorbidity. QOL and global health were very high in patients without comorbidity and remained at the same level

Table 2. EORTC QLQ-C30 and EORTC QLQ-H&N 35 questionnaires.

	After 1 y		After 5 y	
	Irradiated $n = 9$	Non-irradiated $n = 11$	Irradiated $n = 9$	Non-irradiated $n = 11$
EORTC QLQ-C30				
Global health status/quality of life	93.5 ± 8.1	74.2 ± 24.6*	83.3 ± 12.5	64.4 ± 30.5†
Physical functioning	85.9 ± 17.5	73.3 ± 23.5	88.9 ± 10.0	68.5 ± 33.3
Role functioning	90.7 ± 14.7	77.3 ± 31.0	88.9 ± 18.6	72.7 ± 38.2
Emotional functioning	94.4 ± 16.7	87.9 ± 22.5	91.7 ± 15.0	79.5 ± 28.0
Cognitive functioning	90.7 ± 12.1	86.4 ± 19.5	88.9 ± 8.3	75.8 ± 27.2
Social functioning	94.4 ± 11.8	86.4 ± 30.6	88.9 ± 16.7	83.3 ± 25.8
Fatigue	13.6 ± 16.5	20.2 ± 30.2	12.3 ± 14.1	24.2 ± 26.7
Nausea and vomiting	0.0 ± 0.0	3.0 ± 6.7	5.6 ± 16.7	1.5 ± 5.0
Pain	13.0 ± 16.2	10.6 ± 25.0	13.0 ± 23.2	9.1 ± 15.6
Dyspnea	0.0 ± 0.0	24.2 ± 36.8	11.1 ± 23.6	27.3 ± 46.7
Insomnia	3.7 ± 11.1	9.1 ± 15.6	3.7 ± 11.1	9.1 ± 15.6
Appetite loss	0.0 ± 0.0	9.1 ± 30.2	7.4 ± 14.7	16.7 ± 28.3
Constipation	3.7 ± 11.1	0.0 ± 0.0	3.7 ± 11.1	3.0 ± 10.1
Diarrhea	0.0 ± 0.0	6.1 ± 13.5	11.1 ± 23.6	6.1 ± 13.5
Financial difficulties	14.8 ± 17.6	6.1 ± 20.1	22.2 ± 37.3	10.0 ± 16.1
EORTC QLQ-H&N35				
Pain	15.7 ± 22.6	6.1 ± 9.9	19.4 ± 11.8	9.1 ± 17.3
Swallowing	19.4 ± 15.6	6.8 ± 9.0*	12.7 ± 14.2	15.8 ± 23.4
Sensory problems	18.5 ± 17.6	15.2 ± 32.0	13.0 ± 23.2	22.7 ± 31.0
Speech problems	13.6 ± 18.2	9.1 ± 14.8	18.5 ± 22.9	14.1 ± 21.1
Trouble with social eating	22.2 ± 19.5	12.1 ± 25.6	21.3 ± 28.0	20.0 ± 28.7
Trouble with social contact	4.4 ± 11.1	5.5 ± 12.9	5.2 ± 15.6	4.2 ± 8.0
Less sexuality	16.7 ± 28.9	14.8 ± 32.7	18.8 ± 30.1	25.0 ± 34.5
Teeth	14.8 ± 33.8	9.1 ± 15.6	25.9 ± 32.4	6.7 ± 21.1
Opening mouth	44.4 ± 28.9	9.1 ± 21.6‡	25.9 ± 32.4	6.7 ± 14.1
Dry mouth	55.6 ± 28.9	21.2 ± 22.5*	51.9 ± 29.4	26.7 ± 34.4
Sticky saliva	33.3 ± 28.9	12.1 ± 16.8	37.0 ± 35.1	30.3 ± 34.8
Coughing	14.8 ± 17.6	27.3 ± 25.0	14.8 ± 17.6	15.2 ± 22.9
Felt ill	3.7 ± 11.1	6.1 ± 20.1	14.8 ± 33.8	15.2 ± 22.9
Pain killers	22.2 ± 44.1	45.5 ± 52.2	22.2 ± 44.1	18.2 ± 40.5
Nutritional supplements	22.2 ± 44.1	9.1 ± 30.2	22.2 ± 44.1	18.2 ± 40.5
Feeding tube	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	18.2 ± 40.5
Weight loss	0.0 ± 0.0	9.1 ± 30.2	22.2 ± 44.1	36.4 ± 50.5
Weight gain	11.1 ± 33.3	27.3 ± 46.7	0.0 ± 0.0	9.1 ± 30.2

Abbreviations: EORTC QLQ-C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30-questions; EORTC QLQ-H&N35, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30 Head and Neck 35-questions.

**Significant difference between irradiated and non-irradiated patients at the same point in time $p < .05$.*

†Significant difference between 5 years after placement and one year after placement $p < .05$.

‡Significant difference between irradiated and non-irradiated patients at the same point in time $p < .01$.

Notes: Results of the functional scales, symptom scales and single items of the EORTC QLQ-C30 and multi-item scales and single items of the EORTC QLQ-H&N 35 questionnaires for the 5 years surviving patients with a functional implant-retained overdenture, at 1 and 5 years after placement of the dentures (for irradiated and non-irradiated patients). For the 1-year results (n = 35 patients) see Schoen et al.[10]

between T_2 and T_3. When comparing the T_1-data and T_2-data, there was a progressive decrease in general health, global health, and cognitive function over time in patients with comorbidity. A tendency toward a decrease in cognitive function ($p = .078$) and an increase in weight loss ($p = .083$) with time was also seen in patients with comorbidity.

Radiotherapy. The global health status in irradiated patients was higher than the non-irradiated patients. However, 5 patients with comorbidity were among the 11 non-irradiated patients, whereas there was only 1 patient with comorbidity among the 9 irradiated patients. When excluding the patients with comorbidity, the differences in the EORTC QLQ-C30 disappeared.

At T_2, the irradiated patients reported a dryer mouth, less opening of the mouth, and more difficulties with swallowing in the QLQ-H&N35 questionnaires (Table 2). At T_3, the differences between irradiated and non-irradiated patients did not reach significance, although trends were seen toward a dryer mouth ($p = .095$) and more pain ($p = .056$) in irradiated patients. When taking comorbidity into account, we saw several differences in the QLQ-H&N35; the irradiated patients reported a dryer mouth, more pain ($p < .05$), less opening of the mouth, more problems in speech, and more problems related to the dentures ($p = .059$).

When comparing the irradiated patients with the non-irradiated patients, over time, global health and global health-related QOL tended to decrease for the irradiated patients ($p = .059$ and $p = .066$).

Survivors versus Nonsurvivors. When looking retrospectively into the 35 patients with functional

Table 3. Comorbidity versus no comorbidity.

EORTC QLQ-C30	Comorbidity $n = 6$	No comorbidity $n = 14$
Global health status/quality of life	48.6 ± 27.6	83.3 ± 16.3*
Physical functioning	50.0 ± 35.5	89.5 ± 9.3*
Role functioning	55.6 ± 44.3	90.5 ± 16.9
Emotional functioning	69.4 ± 33.6	91.7 ± 14.2
Cognitive functioning	63.9 ± 30.6	89.3 ± 10.5
Social functioning	69.4 ± 28.7	92.9 ± 14.2
Fatigue	40.7 ± 26.0	9.5 ± 12.2*
Nausea and vomiting	2.8 ± 6.8	3.6 ± 13.4
Pain	16.7 ± 18.3	8.3 ± 19.3
Dyspnea	61.1 ± 49.1	2.4 ± 8.9†
Insomnia	11.1 ± 17.2	4.8 ± 12.1
Appetite loss	33.3 ± 33.3	4.8 ± 12.1
Constipation	5.6 ± 13.6	2.4 ± 8.9
Diarrhea	11.1 ± 17.2	7.1 ± 19.3
Financial difficulties	16.7 ± 18.3	15.4 ± 32.2

Abbreviation: EORTC QLQ-C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30 questions.
**Significant difference between patients with and without comorbidity after 5 years $p < .01$.*
†Significant difference between patients with and without comorbidity after 5 years $p < .05$.
Notes: Results of the functional scales, symptom scales, and single items of the EORTC QLQ-C30 for patients with and without comorbidity, 5 years after placement of the dentures.

dentures at T_2, there were some differences between the 5-year survivors with functional dentures ($n = 20$) and those patients who did not make it to T_3 ($n = 12$; the results are not depicted in a table in this article). At T_2, the 5-year survivors had reported a higher global health and fewer problems with swallowing ($p < .05$) than the nonsurvivors. Nonsurvivors tended to report more pain and a lower general QOL than the survivors ($p = .068$).

Oral Health Impact Profile, Functional Assessments, Social Restrictions, and Denture Satisfaction. The OHIP results are presented in Table 4, and the results of questionnaires regarding oral func-tioning and denture satisfaction are presented in Table 5. Over time, there were no changes in results for the total group, neither were differences seen between patients with or without comorbidity.

Radiotherapy. A tendency toward more pain was reported in the OHIP in the irradiated group ($p = .067$) between T_2 and T_3. When excluding patients with comorbidity, more differences were found between irradiated patients and non-irradiated patients: at T_3, irradiated patients reported more functional limitations and physical pain ($p < .05$) than non-irradiated patients, a tendency was seen toward more physical disability ($p = .081$) and a higher score in the handicap domain ($p = .081$) in irradiated patients. Previously, we reported that overall denture satisfaction was higher in non-irradiated patients than in irradiated patients at T_2,[10] but in the irradiated patients, denture satisfaction was also rather

Table 4. OHIP questionnaire.

	After 1 y		After 5 y	
	Irradiated $n = 9$	Non-irradiated $n = 11$	Irradiated $n = 9$	Non-irradiated $n = 11$
OHIP14	12.4 ± 10.9	6.3 ± 8.9*	12.8 ± 12.1	6.7 ± 6.5
Functional limitation	12.0 ± 6.5	6.6 ± 5.4†	11.1 ± 5.9	7.3 ± 4.8
Physical pain	7.0 ± 9.5	4.0 ± 6.3	11.0 ± 9.6	4.3 ± 6.1‡
Physical disability	13.0 ± 10.7	5.9 ± 8.1§	10.4 ± 10.5	6.2 ± 6.3
Psychological discomfort	2.1 ± 5.3	0.8 ± 1.9	3.4 ± 5.8	1.0 ± 2.0
Psychological disability	2.0 ± 4.3	0.9 ± 2.4	1.9 ± 3.6	0.9 ± 1.0
Social disability	1.3 ± 2.5	0.8 ± 1.8	1.3 ± 2.7	0.9 ± 1.3

Abbreviations: OHIP, Oral Health Impact Profile.
**Significant difference between irradiated and non-irradiated patients at the same point in time; $p < .05$.*
†Tendency toward difference between irradiated and non-irradiated patients at the same point in time; $p = .056$.
‡Tendency toward difference between irradiated and non-irradiated patients at the same point in time; $p = .067$.
§Tendency toward difference between irradiated and non-irradiated patients at the same point in time; $p = .056$.
Notes: Results of the Oral Health Impact Profile (OHIP) questionnaire, at 1 and 5 years after placement of the dentures, for irradiated and non-irradiated 5-year survivors with a functional implant-retained overdenture. For the 1-year results (n = 35 patients) see Schoen et al.[10]

Table 5. Oral functioning and denture satisfaction.

	After 1 y		After 5 y	
	Irradiated $n = 9$	Non-irradiated $n = 11$	Irradiated $n = 9$	Non-irradiated $n = 11$
GARS-D	2.6 ± 4.6	1.9 ± 3.9	3.5 ± 5.0	2.8 ± 5.1
Denture satisfaction	12.9 ± 4.8	11.6 ± 4.4	13.9 ± 4.8	11.8 ± 3.1
Overall denture satisfaction	8.4 ± 1.2	8.5 ± 1.4	8.5 ± 1.3	8.9 ± 1.1
Chewing/eating	7.4 ± 7.0	3.8 ± 4.3	6.0 ± 6.7	4.6 ± 4.9
LASA quality of life	81.8 ± 18.5	69.3 ± 24.9	87.4 ± 9.5	65.3 ± 28.7*

Abbreviations: GARS-D, Groningen Activity Restriction Scale Dentistry; LASA, Linear Analogue Self Assessment.
**Tendency toward difference between irradiated and non-irradiated patients at the same point in time p = .055.*
Notes: Results of questionnaires regarding oral functioning and denture satisfaction, at 1 and 5 years after placement of the dentures, for irradiated and non-irradiated patients with a functional implant-retained overdenture. For the 1-year results (n = 35 patients) see Schoen et al.[10]

high. On the other scales of functional assessment, the non-irradiated patients showed better results than the irradiated patients at T_2.[10] At T_3, denture satisfaction again scored high, but denture satisfaction and functional assessment showed no differences between irradiated and non-irradiated patients. Overall QOL, as measured with the LASA, showed, as did the EORTC QLQ-C30, a higher QOL for the irradiated patients after 5 years ($p = .055$), but this difference disappeared when taking comorbidity into account.

Survivors versus Nonsurvivors. At T_1, nonsurvivors reported to be more concerned with the future functioning of their dentures than the 5-year survivors ($p < .05$). There tended to be more social restrictions and chewing problems ($p = .095$ and $p = .074$) for the non-survivors than for the survivors. At T_2, survivors reported less social restrictions than nonsurvivors ($p = .059$). Also, survivors tended to be more satisfied with their dentures than the nonsurvivors ($p = .087$).

DISCUSSION

The surviving 20 patients with functional dentures did not report a difference in oral function between 1 year and 5 years after prosthetic rehabilitation. The observed deterioration in overall global health and QOL was strongly associated with concurrent comorbidity in 6 patients. For patients without known comorbidity, general QOL and global health were very high.

No difference in oral function was reported at the 1 year and 5 year follow-ups after placement of the prostheses. This observation is comparable to results of studies in healthy subjects.[21,22] The oral function of the patients in this study was reasonable, but lower than in healthy subjects.[27] Still, the denture satisfaction was very high. However, there was a difference in global health, oral and social functioning, and denture satisfaction between the 5-year survivors and the nonsurvivors, indicating a "natural" selection of patients. This is in agreement with the findings of other studies,[30,31] where high scores of functioning scales and low scores on symptom items at 1-year follow-up seemed to predict a high survival at 5 years. In our study, survivors reported fewer problems with swallowing and less restrictions in social activities. The nonsurvivors were more concerned with the future functioning of their dentures than the survivors. An explanation can be that the 20 patients with a functional denture had a lower percentage of large tumors compared to the nonsurvivors (Table 1), thus needing less extensive surgery with less morbidity. Also, among the deceased and excluded patients at T_3, a larger percentage had received radiotherapy in comparison to the survivors, probably giving less favorable oral conditions.

The scores of the EORTC QLQ-C30 and QLQ-H&N35 questionnaires at T_3 are comparable to the results of other QOL studies in patients with head and neck cancer.[30–34] The patients without known comorbidity reported high scores comparable to those of healthy subjects. This observation indicates that even after oncological treatment, patients still can reach "normal" health levels. Furthermore, in previous studies, the question was raised whether patients do value oral rehabilitation as essential in their life after head and neck cancer. In one study reporting on general QOL in patients without an implant-borne overdenture, no difference in general QOL was found between the patients who wore their mandibular dentures and patients who did not.[35] A review relating QOL to functional outcome also showed no difference in QOL between patients with a conventional dental/tissue-supported denture, an implant-retained overdenture, and patients without dentures.[17] Most patients reported satisfactory outcomes regardless of the type or presence of prosthetic rehabilitation. This finding is in agreement with the findings of Murphy et al,[18] as data correlated QOL with functional outcome and symptom burden often fails to demonstrate a consistent relationship. The latter authors suggested that this may be attributed to methodological issues in the study design or the patient's ability to adapt to functional and symptom control problems.

It is obvious that certain stages of disease and cancer treatment will lead to disastrous anatomic or physiological conditions in which oral rehabilitation cannot be restored to a level comparable to the level before onset of the disease. However, the patients' ability to adapt to functional problems and to accept the loss of some oral functions should not be underestimated. Another conclusion could be that validated sensitive instruments to rate the influences of oral rehabilitation on QOL are still not available for general application. Regarding general health-related QOL, such validated instruments are commonly available.[15] However, these general health-related QOL questionnaires seem to lack the discriminating ability to measure the effects of prosthodontic treatment on QOL in patients with oral cancer. Efforts have been made to develop instruments that might solve this problem, such as Liverpool Oral Rehabilitation Questionnaire, which was developed in 2004 and has been used ever since.[36–39] Also, more specific questionnaires that focus on head and neck function, such as speech and swallowing are currently available.[40] Unfortunately, we were not able to use such questionnaires as these questionnaires were not available at the time of inclusion of our patients into our study.

It seems that other factors such as comorbidity are far more important in determining the patients' QOL being an important caution that has to be considered when interpreting the results of the questionnaires regarding general health. With a closer look, the decrease in QOL we observed appeared to be caused by a small group of patients with severe comorbidity. Most patients with comorbidity were not irradiated. When taking this comorbidity into account, the specific head and neck module reveals differences between the irradiated and non-irradiated patients even after 5 years, which can be related to the late effects of the radiotherapy, such as dry mouth, less opening of the mouth, and problems with swallowing and speech. Terrell et al[41] ranked comorbidity to be the second greatest predictor of decreased QOL in patients with head and neck cancer. In our study, we did not apply standard comorbidity measures as the Adult Comorbidity Evaluation-27, that are currently used in studies to code and quantify comorbidity.[42–44] Nevertheless, we were able to indicate that comorbidity apparently played a larger role in decreased QOL scores than radiotherapy. However, 2 patients received radiotherapy between T_2 and T_3 due to recurrent disease. In the analysis, these patients were scored as non-irradiated (intention-to-treat procedure) and were considered as having comorbidity. This could also explain why differences are only found in the head and neck module when excluding patients with comorbidity.

Implant loss was higher in patients who received radiotherapy post–tumor surgery. This is in agreement with other studies.[5,7,8,11] A review reports that the increase in the risk of implant failure in irradiated patients may be up to 12 times greater; however, the magnitude of this difference should be accepted with caution, because studies making these comparisons are of poor to moderate quality.[12] The failure rate of 10.6% in irradiated bone over a period of 5 years found in our study is considered good. However, 26 patients had died and the percentage of patients who had received postoperative radiotherapy decreased over time among the survivors (73% at baseline vs 54% 5 years after placement of the dentures [$n = 20$] and patients that survived). This could have contributed to the relatively low failure rate of implants in irradiated bone.

The percentage of patients rehabilitated with the help of dental implants placed after ablative surgery and postoperative radiotherapy varies in the literature. Reported percentage are between 22% and 91%,[9,14,45–50] depending largely on the type of patients included, the type of reconstruction, the survival rate of patients and implants, and the length of the follow-up. In our study where the implants were placed during ablative surgery, a relatively large number of the living patients were rehabilitated with dentures (at T_2, 92%; at T_3, 83%). No delay or complications in oncological treatment were seen due to the placement of the implants at that time. Still, 2 patients refused abutment connection because of the expected extra burden of abutment connection surgery. Also, from previous data, it was concluded that many patients refrain from further surgery, including implant installation, after they survived head and neck oncology treatment, despite an improvement of oral functioning that was to be expected postsurgery.[35] When placing the implants during ablation, a significant time reduction of (pre)prosthetic rehabilitation can be achieved. Consequently, a large percentage of patients and even patients with a worse general prognosis can benefit for some time from the improvements in aesthetics and oral function. Future studies might identify patients who are less likely to benefit from implant placement per ablation. Our study indicates that implant installation during ablative surgery results in a high percentage of rehabilitated patients, also after 5 years. From a health economics point of view, however, the loss of resources needs further consideration by performing a cost-effectiveness analysis.

Based on this study, we conclude that the overall global health and QOL deteriorated in the total group between 1 and 5 years after placement of the dentures, which was due to concurrent comorbidity in a small number of patients. The global health and QOL for patients without comorbidity was very high. A large number of surviving patients could benefit from an implant-retained mandibular overdenture (83%)

after 5 years. The oral function and denture satisfaction was high and did not change over time for the 5-year survivors.

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